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INVESTIGATION OF CALIBRATION DISCREPANCIES OF TILE-TYPE HYDROPH--ETC(U)

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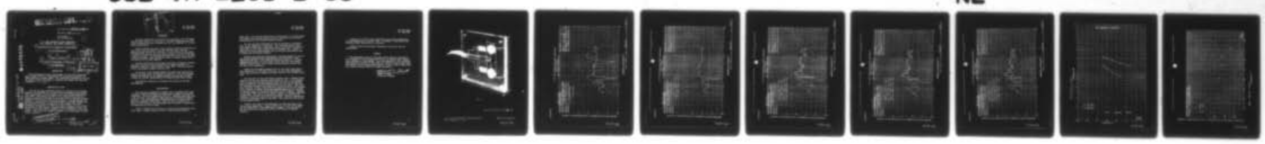

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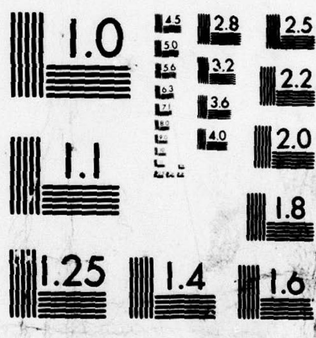

MICROCOPY RESOLUTION TEST CHART

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U. S. NAVY UNDERWATER SOUND LABORATORY
FORT TRUMBULL, NEW LONDON, CONNECTICUT

AD A073676

INVESTIGATION OF CALIBRATION DISCREPANCIES OF TILE-TYPE HYDROPHONE

By

Robert O. Kindl

USL Technical Memorandum No. 2231-2-68

23 April 1968

13p.

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INTRODUCTION

Wide discrepancies were noted between the acoustic calibrations made at Dodge Pond of an experimental USL tile-type hydrophone and those made by an outside vendor. This memorandum describes the results of initial studies undertaken to determine the reasons for these discrepancies. → to pg. 4

DESCRIPTION OF UNIT

The USL tile-type hydrophone (Figure 1) consists of two ceramic elements, each followed by a 20 dB low noise microminiature preamplifier, encapsulated in a polyurethane tile, nine inches square by one inch thick. Each element is made up of a 1/8 inch thick, $1\frac{1}{2}$ inch diameter ceramic disc (thought to be either PZT-5A or barium titanate) backed by a $\frac{1}{4}$ inch thick, $1\frac{1}{2}$ inch brass mass. A ten ohm one per cent resistor is inserted in the low side between the ceramic elements and the amplifiers to permit calibration of the system. This unit, originally constructed as a model for patent purposes, is by no means the optimum or final design. Responses made on elements A and B are similar. Only data taken on element A will be described in this memorandum. The position of element A referred to in this report is indicated in Figure 1.

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BACKGROUND

The first calibration on this unit was obtained at the USL Dodge Pond Facility, Barge 1, in June 1967. The water temperature was 54°F. Initial calibrations were performed with the tile cemented to a $\frac{1}{2}$ inch steel backing plate.

Figure 2 reports the open circuit crystal receiving sensitivity of unit A both with and without the steel backing plate, over the frequency range from 100 Hz to 20 kHz. In the 1 kHz to 20 kHz range the sensitivity without the steel backing varies as much as 12 dB with a notch at 1.6 kHz. The measured mean sensitivity was -95 to -98 dB// 1 volt/1 μb, where a mean sensitivity (based on ceramic dimensions) of -106 dB//1 volt/1 μb was expected.

The high sensitivity and the wide variations in response prompted Code 2112 to have the array recalibrated at General Dynamics in Rochester, New York. This was done in July 1967. The water temperature in the General Dynamics tank was 72°F.

The results of the General Dynamics and Dodge Pond calibrations without the steel plate are compared in Figure 3. Note that the mean sensitivity measured at the General Dynamics facility was -106 dB// 1 volt/1 μb, $\pm 1\frac{1}{2}$ dB, approximating the predicted value more closely.

Code 2230 was requested to determine the reason for the wide discrepancies.

INVESTIGATION

The array was recalibrated at Dodge Pond, in December 1967, both in Barge 1 using CW techniques as before, and in Barge 3 using pulse techniques. The water temperature was 37°F. Responses were made from 1 kHz to 20 kHz, the frequency range covered at the General Dynamics facility. This calibration was performed without the steel plate as were all subsequent calibrations. This was done to eliminate the effects of the plate on the measurements and to provide a common basis for comparing all sets of data.

Figure 4 compares this second set of Dodge Pond measurements with those made at General Dynamics and with those previously made at

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Dodge Pond. The receiving sensitivity obtained above 1.6 kHz was somewhat higher than previous Dodge Pond data, resulting in even greater discrepancies with the General Dynamics results.

The unit was then calibrated at Clevite Corporation, Cleveland, Ohio, at the suggestion of Code 2112. The resulting Clevite sensitivity made in 41°F water temperature agrees closely with the measurements made in 37°F water at Dodge Pond in December 1967. Figure 5 compares the Clevite measurements with the previous measurements made at Dodge Pond and General Dynamics.

Finally, the array was recalibrated at General Dynamics to see if the earlier General Dynamics measurements were repeatable. Water temperature was 63°F. The resulting sensitivity curve was in closer agreement with Dodge Pond and Clevite curves than with the previous General Dynamics curve. The original General Dynamics results were not found to be repeatable.

Except for the General Dynamics data of July 1967, which gave a mean sensitivity of -106 dB//1 volt/1 μb, all the other measurements gave a mean sensitivity between -93 dB//1 volt/1 μb and -98 dB//1 volt/1 μb.

For the tests of July 1967 General Dynamics used a transmit pulse length of 2.5 ms and a receiver pulse length of 3 ms. It is possible that by measuring the whole received pulse the nulls in the response were not observed. The peak detector would see the turn-on and turn-off transients instead of the signal portion of the pulse. Tests have been conducted at Dodge Pond which show a definite null in the received pulse, however, transients were also observed which could be recorded as received signal if the receive gate was not set properly. Attempts to duplicate these conditions at General Dynamics in February 1968 were inconclusive. The null at 2 kHz was not present nor could the low response of -106 dB//1 volt/1 μb be duplicated. Figure 6 compares the pertinent calibrations made on the array. Two major nulls are evident in the response curve.

Figure 7 is a plot of the frequencies at which the nulls occur versus water temperature. Figure 8 shows that the nulls shift toward the low frequencies as the temperature increases. This may explain why the null was not observed at 2 kHz in 63°F water at General Dynamics.

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Figure 8 is a plot of mean sensitivity versus water temperature for two frequencies, 4 kHz and 7 kHz. A decrease in sensitivity with increasing water temperature is indicated.

Figure 9 gives the pertinent information for each of the six calibrations.

SUMMARY

The measurements made on the array clearly show the sensitivity to be dependent on some unidentified factor, as perhaps water temperature, pressure, or microbubbles. Tests are scheduled at the Underwater Sound Reference Division of NRL, where the effects of water temperature and pressure will be investigated further. Further tests at Dodge Pond will examine possible effects of bubble adherence.

Robert O. Kindl

ROBERT O. KINDL
Electronic Engineer

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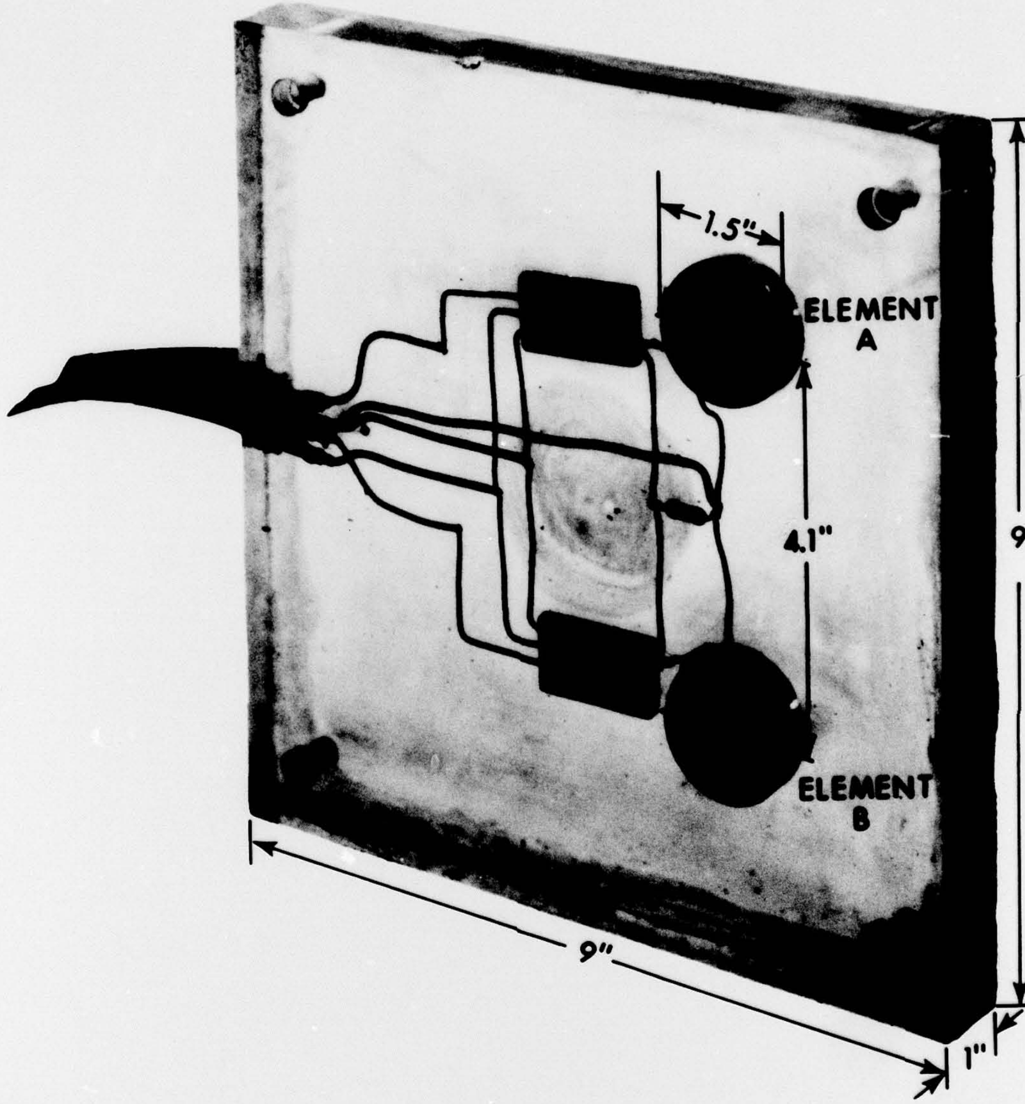

Fig. 1

USL Tech Memo No. 2231-2-68

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Official Photograph

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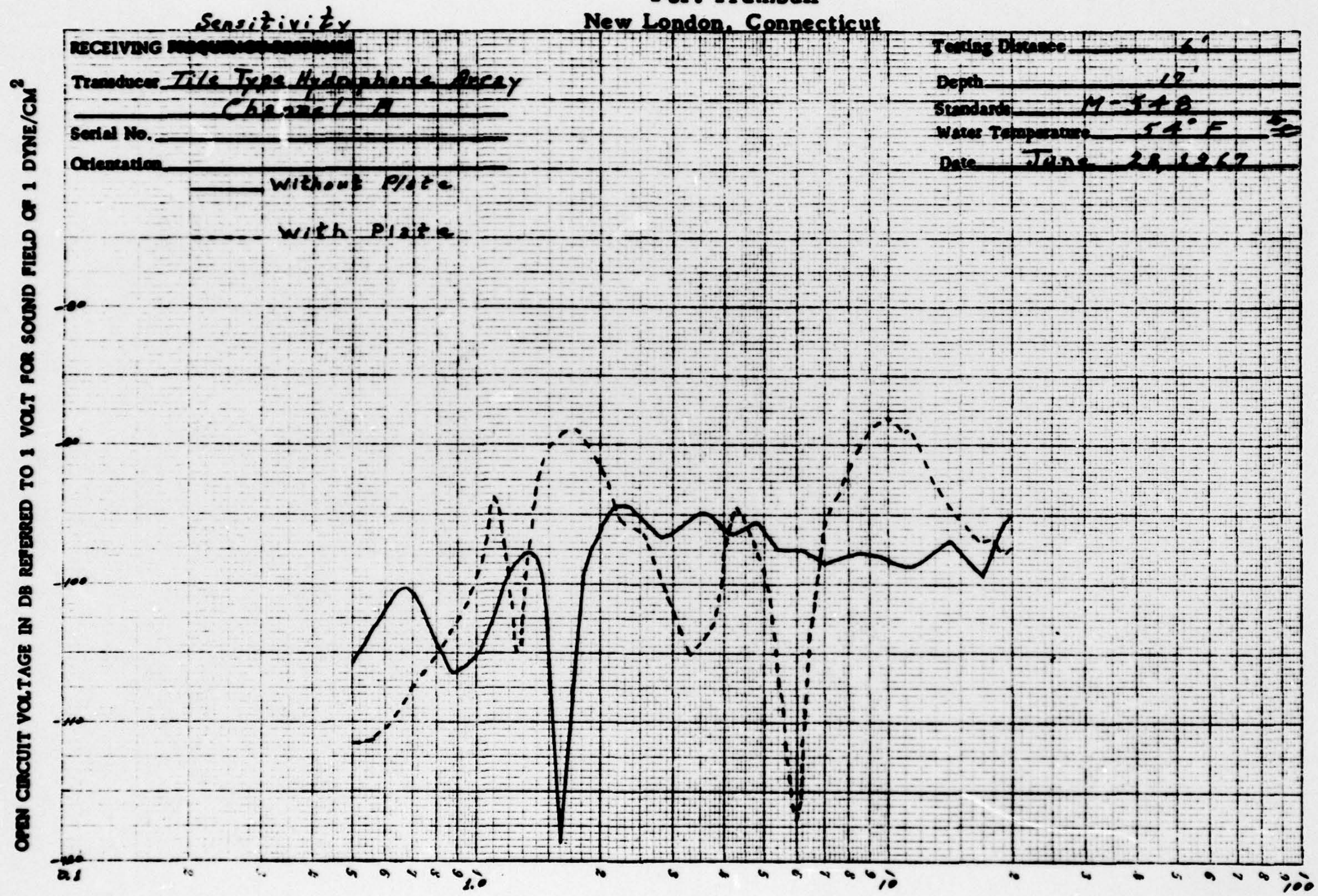

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Fig. 2 To 2231-2-68 Dtd. 4-23-68

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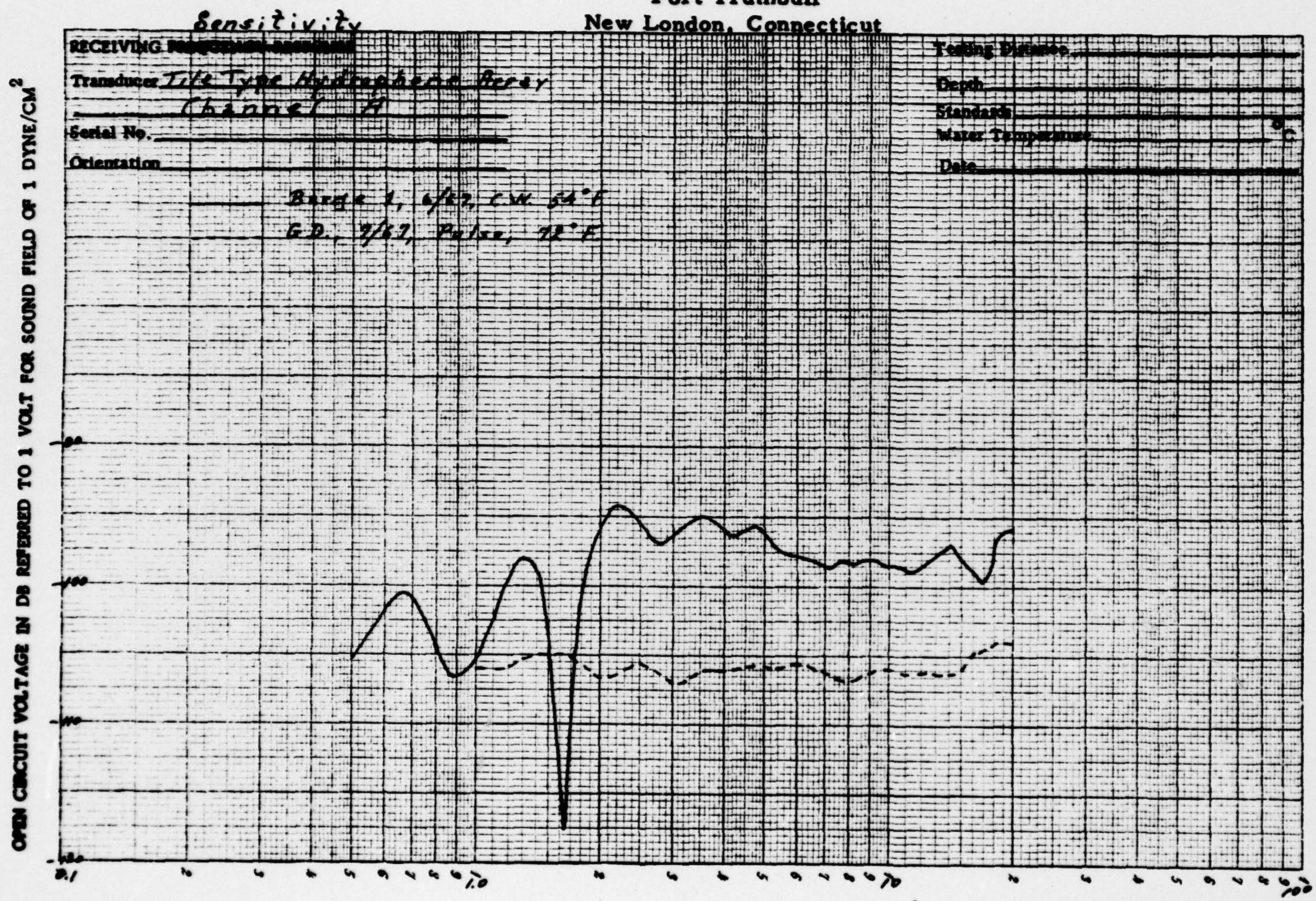

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Fig. 3 To 2231-2-68 Dtd. 4-23-68

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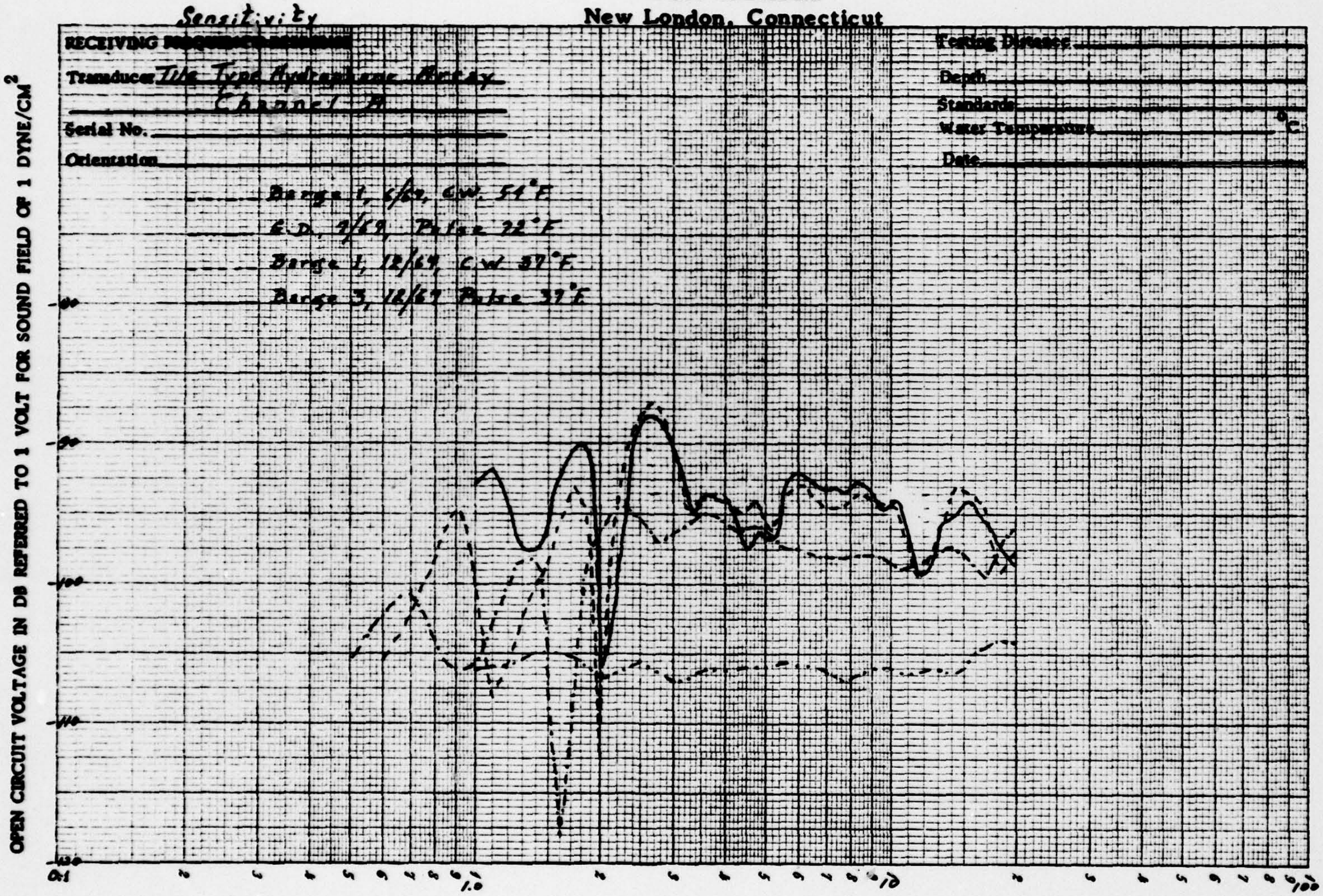

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Fig. 1 To 2231-2-68 Dtd. 4-23-68

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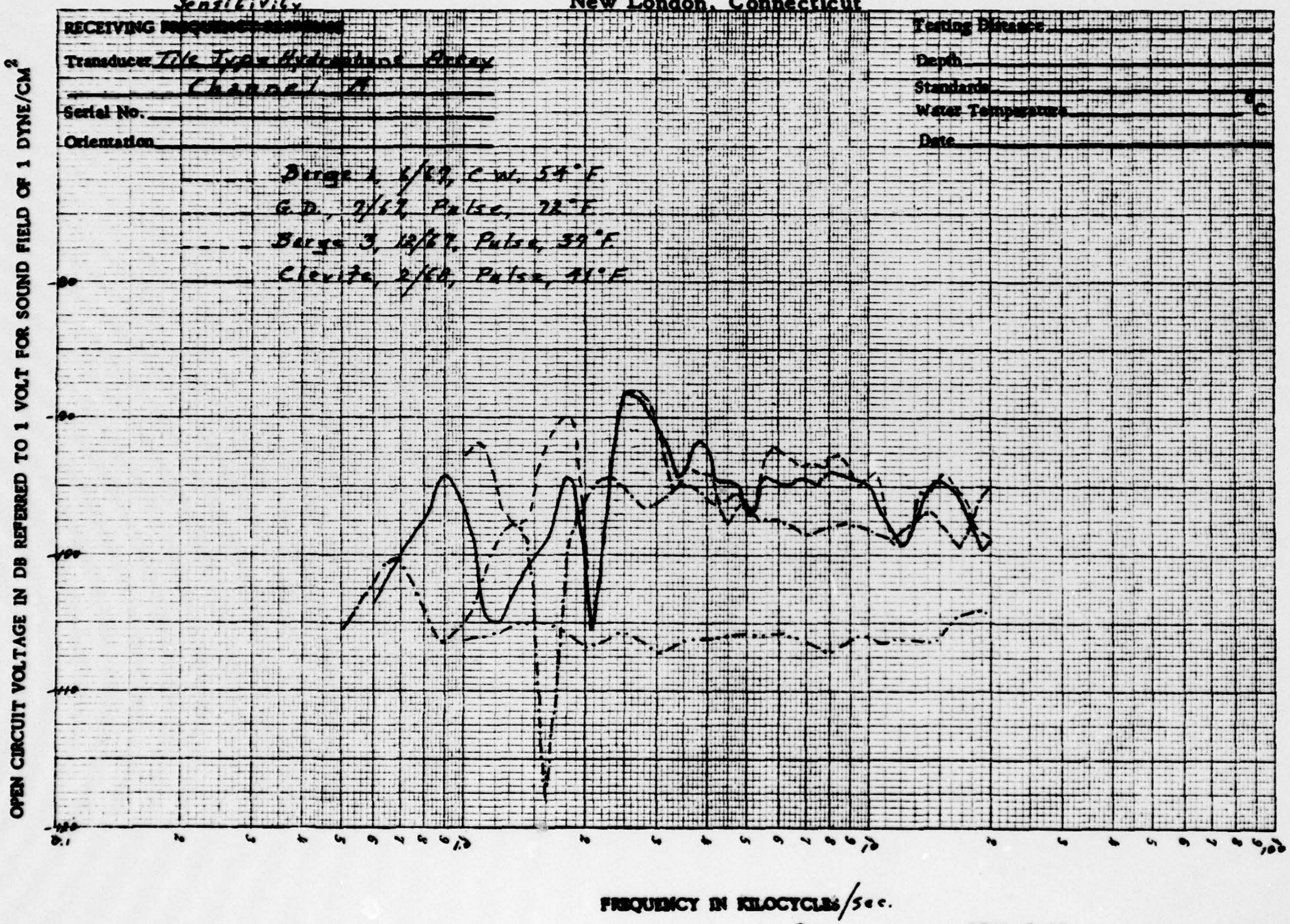

Fig. 5 To 2231-2-68 Dtd. 4-23-68

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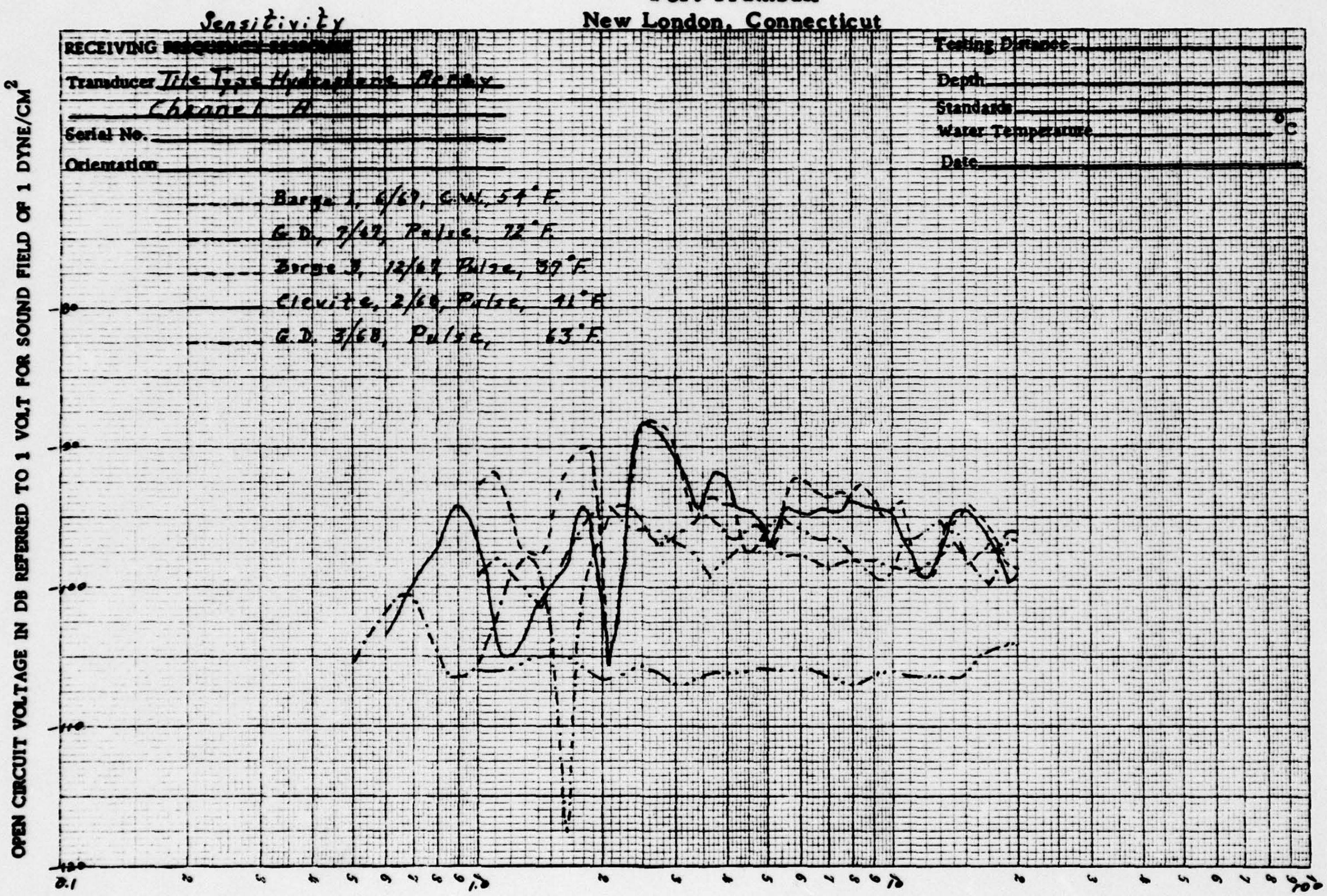

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Fig. 6 To 2231-2-68 Dtd. 4-23-68

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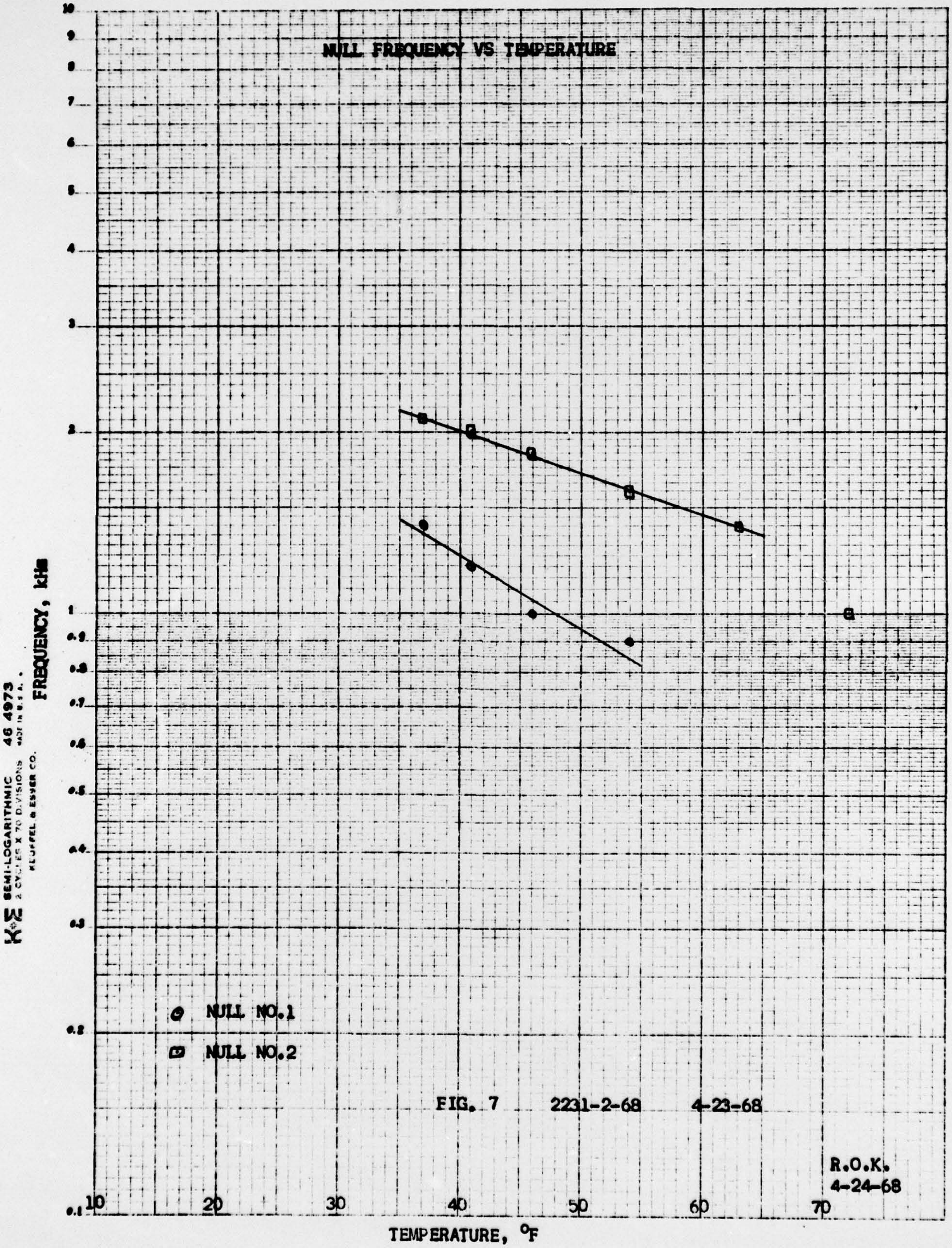

FIG. 7 2231-2-68 4-23-68

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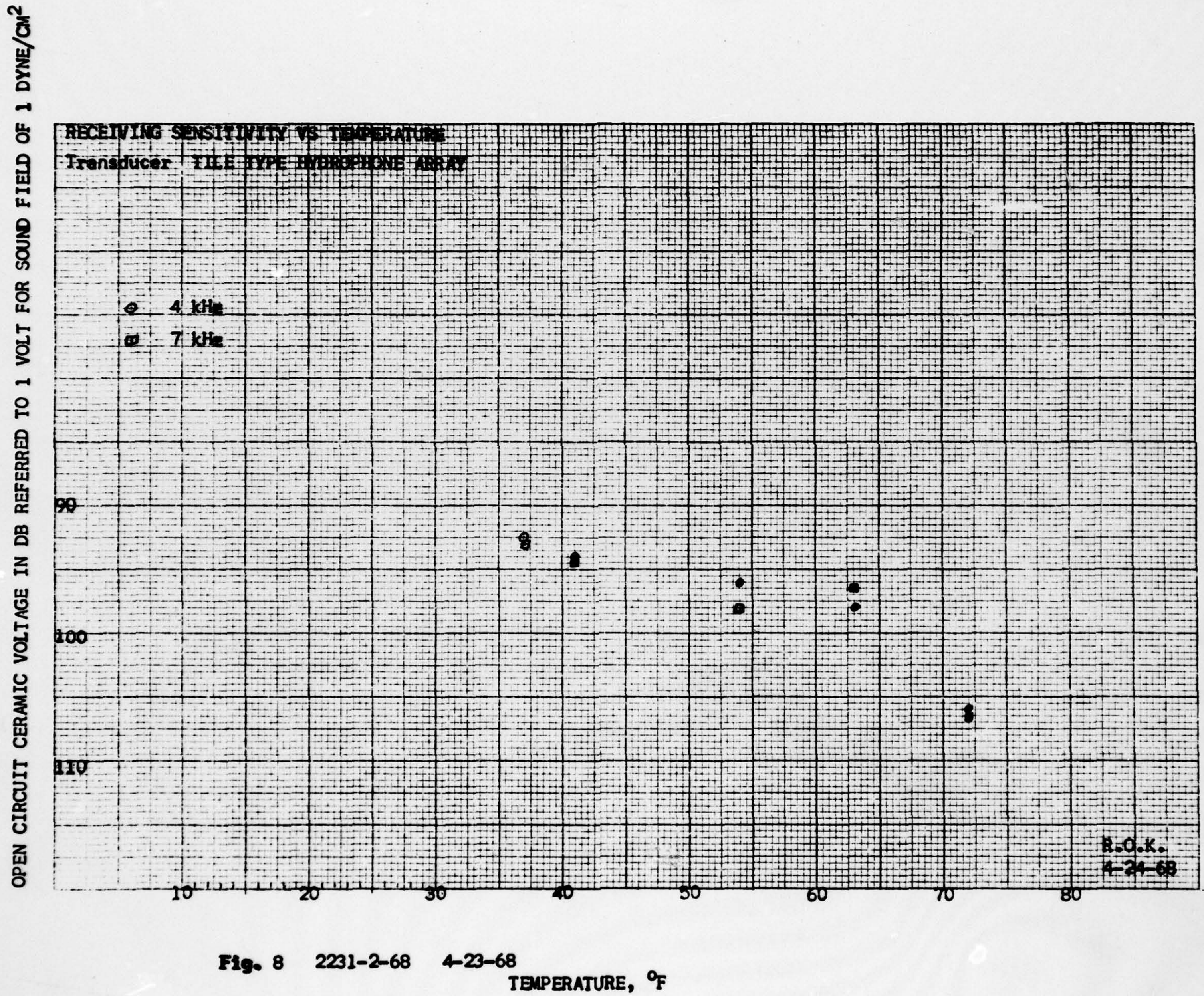

Fig. 8 2231-2-68 4-23-68

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MEASUREMENT CONDITIONS AND SUMMARY

TEST LOCATION, MODE, DATE	DEPTH FT	DISTANCE	WATER TEMP, °F	MEAN SENS. dB//1 v/1 μb	VARIATIONS
USL, BARGE 1 CW JUNE 1967	17	6 & 8 FT	54	-95.6	±2 dB, 2-20 kHz Nulls at 0.9 & 1.6 kHz
GENERAL DYNAMICS PULSE JULY 1967	12	6 FT	72	-106	±1.5 dB
USL, BARGE 1 CW DEC 1967	17	6 & 8 FT	37	-93.5	±6 dB, 2.1-20 kHz Nulls at 1.1 & 2.0 kHz
USL, BARGE 3 PULSE DEC 1967	17	6 & 8 FT	37	-93.5	±6 dB, 2.1-20 kHz Nulls at 1.4 & 2.0 kHz
CLEVITE PULSE FEB 1968	30	2 METERS	41	-94	±4 dB, 2.2-20 kHz Nulls at 1.2 & 2.0 kHz
GENERAL DYNAMICS PULSE MARCH 1968	12	6 FT	63	-96.5	±3 dB, 1.5-20 kHz Null at 1.4 kHz

Fig. 9 2231-2-68 4-23-68

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